GEORGIA INSTITUTE OF TECHNOLOGY | OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. ______

Project No. E-25-606 | GTRI/~~GIT~~ | DATE 6 /14 /83

Project Director: Dr. John T. Berry | School/~~Lab~~ ME

Sponsor: National Science Foundation

Type Agreement: Grant No. MEA-8312829

Award Period: From 5/15/83 To ~~7/31/83~~ 11/30/83 (Performance) 10/31/83 (Reports)

Sponsor Amount:

	This Change	Total to Date
Estimated:	$ 5,318	$ 5,318
Funded:	$ 5,318	$ 5,318

Cost Sharing Amount: $ N/A | Cost Sharing No: N/A

Title: Travel to Sweden to Examine Programable Automation Developments in Metal Casting Industries, June 1983; and Visit University of Wales, United Kingdom.

ADMINISTRATIVE DATA

OCA Contact Faith Costello

1) Sponsor Technical Contact:

Dr. William M. Spurgeon
Production Research Section
Division of Mechanical Engineering and applied Mechanics
Directorate for Engineering
NSF
Washington, D. C. 20550 (202)357-7540

2) Sponsor Admin/Contractual Matters:

Terry J. Pacovsky, Sec. I, AAED/Engineering Branch
Division of Grants & Contracts
Directorate for Administration
NSF
Washington, D. C. 20550
(202) 357-9626

Defense Priority Rating: N/A | Military Security Classification: N/A

(or) Company/Industrial Proprietary: ______

RESTRICTIONS

See Attached NSF Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT

COMMENTS:

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GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date June 28, 1984

Project No. E-25-606

School/~~xxx~~ ME

Includes Subproject No.(s)

Project Director(s) Dr. John T. Berry GTRI / ~~xxx~~

Sponsor National Science Foundation

Title Travel to Sweden to Examine Programmable Automation Developments in Metal Casting Industries, June 1983; and visit University of Wales, United Kingdom

Effective Completion Date: 11/30/83 (Performance) 2/28/84 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [x] Final ~~Invoice or Final Fiscal Report~~ FCTR
- [ ] Closing Documents
- [x] Final Report of Inventions if positive
- [x] Govt. Property Inventory & Related Certificate if positive
- [ ] Classified Material Certificate
- [ ] Other

Continues Project No. Continued by Project No.

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Form OCA 60:1028

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT

NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I–PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
Georgia Institute of Technology Atlanta, GA 30332	MEA/Travel	MEA-8312829
	4. Award Period From 5/15/83 To 11/30/83	5. Cumulative Award Amount $5318

6. Project Title

Travel to Sweden to examine Programmable Automation Development in Metal Casting Industries, etc.

PART II–SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

The output figures for the Swedish metal casting industry have indicated in the past a very high level of productivity in terms of tons poured per person year. There are also indications that individual Swedish foundries have the capability of exceeding the figures quoted in the literature by a very considerable margin. (See figures collected and discussed in a previous paper by C.W. Meyers and J.T. Berry, TrAFS (87) 1979)

A team of individuals from Schools or Department's of Metallurgy, Mechanical Engineering, Industrial Engineering and Social Sciences at two major, US Universities,* visited foundries representative of these high output figures to determine the various factors (technical, organizational, and societal) which contribute to this high output character. They were aided in selecting the foundries concerned by the Swedish Foundrymen's Association in Jonkoping, Sweden.

The visit also afforded an opportunity to determine how the CAD-CAM related process modeling aspects being studied by GT/UM teams under the NSF supported CADCAST project related to the various developments in contemporary Swedish foundry technology.

The various organisations visited involved both ferrous and non ferrous casing operations. Both die-casting and sand founding plants of medium and high production were visited. Important socio-economic, as well as socio-technical factors were judged to be at least as important as the automation equipment related developments seen, which were more of a fixed nature, rather than programmable. In the majority of instances, high productivity resulted from lean management teams frequently led by one individual with an adequate control span and who viewed the founding as a system and demonstrated sound understanding of component interworking.

*The Georgia Institute of Technology and The University of Michigan

PART III–TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM: Check (✓)	Approx. Date
a. Abstracts of Theses	X				
b. Publication Citations	X				
c. Data on Scientific Collaborators	X				
d. Information on Inventions	X				
e. Technical Description of Project and Results				x	Sept 1984
f. Other *(specify)* Abstract of paper offered to Modern Castings (AFS)					

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
John T. Berry		14 June 1984

Some Observations on Automation Developments

in the Swedish Metal Casting Industries

by

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The Georgia Institute of Technology, Atlanta, Georgia

and

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[‡] Department of Industrial and Operations Engineering

Study supported by NSF Grant MEA - 83 128 29
(Program Manager - Dr. W. Spurgeon)

EXTENDED ABSTRACT

During the Summer and Fall of 1983 visits to selected Swedish metal casting plants were made by a multidisciplinary team representing the areas of Materials, Mechanical and Industrial Engineering and Social Sciences.

The objective of the visits was to determine the contribution being made to the productivity of Swedish Foundries and Die Casting Shops by programmable automation and other robotics related devices. In addition to this, the acceptance of automation/mechanization plans by the workforce and management style extant in Swedish metal casting plants was also examined, since it was anticipated that there would be considerable interplay between technical and social factors that affect foundry operations.

(i) Background
Contemporary Sweden has been referred to as a state that practices "welfare capitalism." By this it is meant that the ownership of Swedish industry is private. At the same time, however, the government is very heavily involved in promoting the socio-economic welfare of the Swedish people throughout their lifetimes, a very expensive proposition. To the casual observer two striking features about Sweden and Swedish life are immediately evident. First, the country is not crowded; second, there is essentially no poverty. In order for the system of "welfare capitalism" to work, it is necessary that there be cooperation between government, labor, and industry. As we learned during our visits, this cooperation exists, though on industry's part it ranges from eager to pro forma. One of Sweden's industrial giants, a major car manufacturer is accustomed to the system and very comfortable with it, while other firms are disturbed by the high taxation and large number of constraints imposed on them.

Automation, whether fixed or programmable, increases productivity by substituting mechanical for human effort and thus decreasing the number of production personnel (including managerial and white collar support) involved in producing a fixed amount of goods. Progress toward automation in Sweden is conditioned by two governmental policies. First, full employment is public policy. Discharging workers to introduce machines is not viewed kindly by the government. Second, each employer must pay a substantial tax per worker. While these influences seemingly pull in different directions, one encouraging employment and the other offering an incentive to limit, Swedish industry has generally adopted a strategy that fosters automation within this framework.

(ii) Foundry automation and the **workforce**
In the course of the visit, gray and ductile iron foundries and a large diecasting shop were visited along with various small high technology entrepreneurial organizations involved in introductory innovation into such industries. Table I lists details of the ten largest units of the gray and ductile sector. Of the foundries listed those visited were Volvo (Skövde), Kockums (Ronneby) and SAAB-SCANIA (Södertälje). All three organizations have modern facilities but between them cover both high as well as medium to short run casting orders.

The basic concept in introducing automation is to focus on the jobs in the foundry that the workers view as least desirable and hence have the highest turnover. Worker turnover is a fact of life in industrial societies, and

Sweden is no exception. These undesirable jobs are the immediate candidates for automation. Workers displaced from these jobs are retrained for more desirable jobs and reassigned elsewhere in the foundry. Workers who resign, up to the number displaced, are not replaced. Attrition accounts for any decrease in employment. Thus the automation of Swedish foundries appears to be an evolutionary, rather than a revolutionary, process. Indeed it is a process that is in midstream since in the foundries we observed, judged to be the most productive in Sweden, fixed automation was not being used to its fullest potential and programmable automation had not yet been introduced.

Why is it then that the productivity rates of the leading Swedish foundries are apparently among the highest in the world? In no way can this be said to be due to a significant technological advantage over other industrialized nations. At the Volvo foundry in Skövde the team told that the amazing year-to-year productivity increase per foundry employee for the last decade was due almost exclusively to employee motivation and the rationalization in foundry procedures, in particular a limited product line, hardly technologically intensive. But if Volvo's investment in human capital was extremely high, all the firms visited were concerned with good working conditions, appropriate health and safety procedures, and worker training. Quality control was taken very seriously.

(iii) Role of Management

A critical factor in the observed high foundry productivity appeared to be sound technical management. In every case, the productivity improvement has been made by a fairly lean management team that was led by one individual with an adequate span of control who viewed the foundry as a system and understood the mutual interworkings of its various components. The dedication of this individual to quality and productivity meant steady progress. The individual could possess charisma or be blessed with a superabundance of common sense, but with this sort of leadership, the parts and operations of the foundry concerned were fitted together in a coherent whole. Clerical and sales operations were in the process of being computerized and integrated with the production process and will no doubt complement technical management aspects referred to above.

One area where high technical capability exists, but integration may be lagging is the relation between the laboratory and the foundry. Although much progress has been made in melt controls of late, it would be very tempting to try to design a system where analyses were conducted on line and in real time instead of post hoc. Such an ideal system would guarantee instant feedback on all aspects of composition. Nonetheless, the technology extant was no better than that practiced in the U.S.

(iv) Robotics in the Foundry

Although a great deal has been written in the European and U.S. literature regarding robot applications in Sweden, the only examples seen during the present series of visits were related to casting cleaning (gray iron). The systems concerned were not computer programmable but utilized the conventional learning by teaching routines.

The Swedish Foundry Research Institute (Svenska Gjuteriföreningen, Jönköping) has done an extensive amount of work reviewing the utilization of industrial robots and manipulators. The majority of the applications concerned would appear to be in steel foundries.

What is so surprising that behind the extremely impressive production figures lies not so much the state-of-the-art of today's technology, but sound technical management with systemic control over operations, the intelligent use of human resources, and the rationalized and well integrated application of proven technologies. All of this functions within a more restrictive sociopolitical environment than in the U.S. It is clear that the Swedish foundry (like every foundry) is a socio-technical system, and continued productivity improvements will result from the integrated development of that system. Technical fixes and people fixes and interlinked.

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Ten Largest Swedish Grey Iron Foundries
Capacity in Metric Tons/Year

Firm	Location	Capacity	# Employees	Alloys	Size Max Casting (kg)
Volvo Komponenter AB	Skövde	60,000	>200	1	310
Sandvik AB	Storå	36,000	50-99	5	40,000
AB Bofors-Akers	Akers-Styckebruk	25,000	100-199	6	50,000
Volvo Komponenter AB	Arvika	22,000	>200	5	350
Kockums Gjuteri AB	Ronneby	22,000	>200	6	50 kg gray 15 kg ductile
SKF Mekanprodukter AB	Katrineholm	16,000	>200	5	100
Alvesta Gjuteri AB	Alvesta	15,000	100-199	5	150
SAAB SCANIA AB	Södertälje	12,500	>200	1	300
EGAB	Halle Fornas	10,000	>200	7	20
Parcå Norrahammar AB	Norrahammar	10,000	100-199	5	300

Source: Svenska Gjuteriföreningen **Medlemsforteckning** (August, 1983)
Box 2132, 550 02 Jonkoping , Sweden